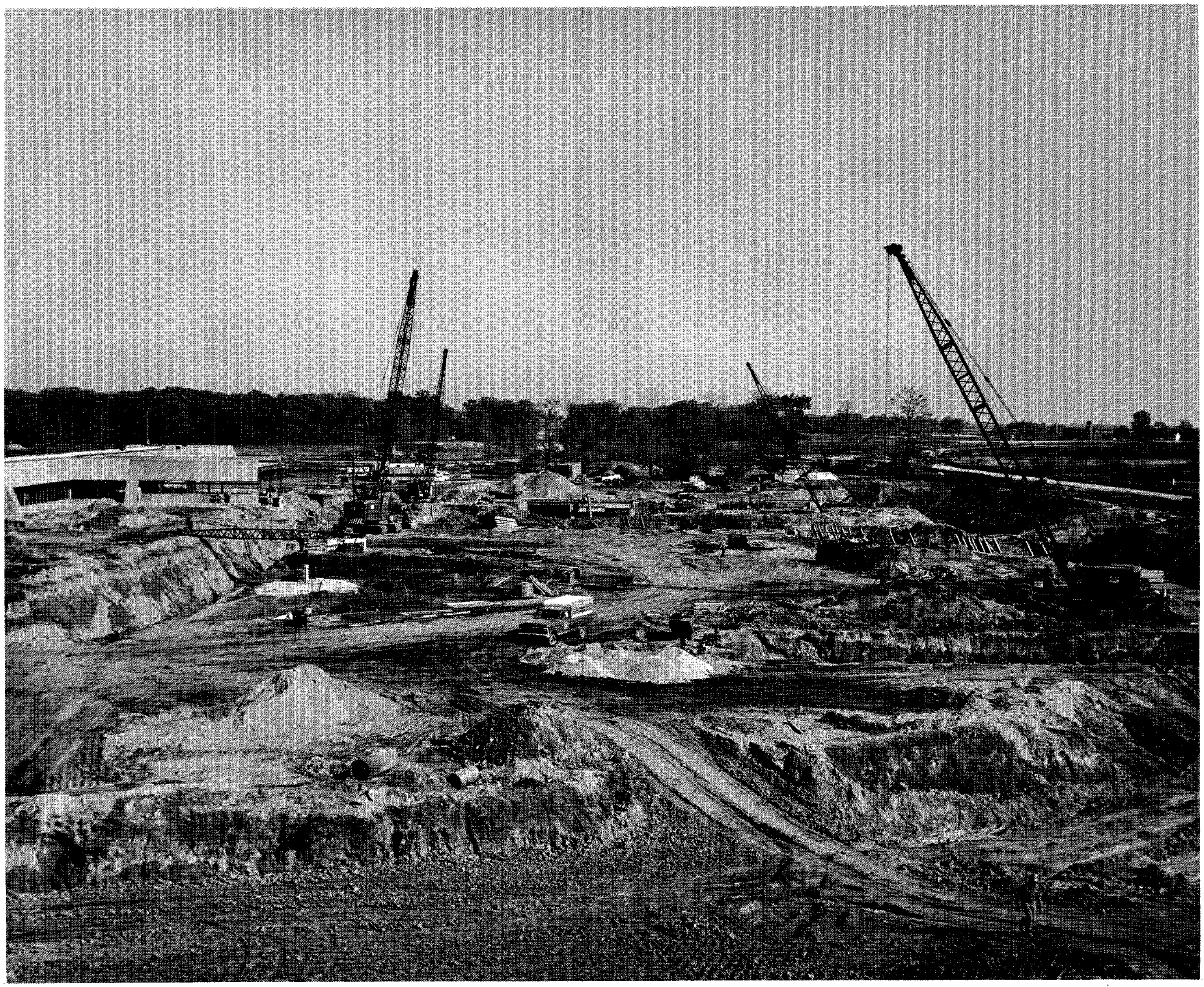
national accelerator laboratory FERMILAB-NAL-033

MONTHLY REPORT OF ACTIVITIES

October 31, 1969



Operated by Universities Research Association Inc. Under Contract with the United States Atomic Energy Commission

national accelerator laboratory

"PROFESSOR OF THE MONTH"
PROGRAM

November 6, 1969

During the past two years we have tried to keep good contact between theoretical physicists and experimentalists who are building the 200 BeV accelerator and planning its experimental facilities. We have done this partly through our summer studies at Aspen, Colorado, and partly through intermitent seminars by visiting theorists. We have now added to our staff five young post-Ph.D. theorists who, as members of our staff, are available to our experimentalists in connection with their current experiments and with their formulation of plans for facilities to be provided for the 200 BeV research program.

This year, as another facet of this program, we are planning to bring to NAL as visiting lecturers some of the theorists who are working with problems connected with physics at higher energies. Each such theorist will be asked to take responsibility for a series of two to six weekly seminars in which he will discuss a problem that is of particular interest to him and of some import to the 200-BeV research program.

We are starting this program of visiting "Professors of the Month" in December. Professor J. J. Sakurai will give a series of three seminars on December 1, 8, and 15, on the subject "Vector Mesons and Electromagnetic Interactions of Hadrons." We welcome visiting theorists and experimentalists who would be interested in participating in these discussions.

Edwin L. Goldwasser

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MONTHLY REPORT OF ACTIVITIES

F. T. Cole

October 31, 1969

Abstract. This report summarizes the activities of the National Accelerator Laboratory in October, 1969.

General

1. Schedule. The scheduled date for completion of installation of main-accelerator components has been advanced from January 1, 1972, to July 1, 1971. Testing of the complete accelerator will begin at that time. Protons of 8-GeV energy will be available from the booster in April, 1971.

2. Funding. The Laboratory is being funded on a month-to-month basis until our fiscal 1970 appropriation is received. We received $7.5 million in September and $9.1 million in October. These and the July and August funds (covered in previous reports) have enabled us to maintain our schedule.

Our construction will be affected by President Nixon's program of slowing down conventional construction. The major contract for conventional construction that we will be able to let in the remainder of fiscal 1970 will be for the below-ground portions of the main-accelerator enclosure. Technical components are not affected by the President's program.

3. New Construction Contracts.

a. Master Substation (Phase I, Increments I and II). A contract was awarded to United Power Contractors on October 13 for approximately $1.031 million for construction of the master substation, which will supply electric power to the entire Laboratory. The substation will be located at the junction of Roads A and B. The contract completion date is October 29, 1970.

b. Footprint Utilities. A contract was awarded to A. J. Lowe and Son, Inc. on October 8 for construction of water and sewer lines in the area of the linac and cross gallery (called the "footprint" because it is the area of the base or footprint of the central laboratory). The contract value is $215,699. The contract is to be completed by January 31, 1970.

c. Temporary Electric Power (Phase I). A contract for $58,400 has been awarded to A. S. Schulman Electric Co. for construction of temporary power facilities to enable operation of the linac and booster before the permanent power facilities are in operation in January 1971. This temporary power contract is to be completed by December 24, 1969.

4. Construction Progress. The cover photograph shows work on 6 separate construction contracts. These are:

a. Linac Building. The building is 85% complete and work is almost entirely inside. The linac extension, which connects the linac and booster, is now complete. Plans are well under way for occupancy of the building by the Linac and Booster Sections in January. In addition, work on controls for the entire accelerator will be carried on in the cross-gallery stub, which is part of the linac contract.

b. Booster Enclosure. A small part of the booster circumference, which had been left undisturbed to provide access to the inside of the ring, is now under construction. The floor slab and tunnel forming are complete in this part. Figure 1 shows this forming work in progress a week ago. It is now possible to walk around the entire booster tunnel. In addition, the earth backfill has been placed over the remainder of the tunnel. Excavation and forming for the utility tunnel across the booster from the utility plant to the cross gallery, which is part of the booster contract, is in progress and can be seen in the cover photograph. Work on the utility plant itself will begin when the booster tunnel below it is complete. The booster contract is now 56% complete.

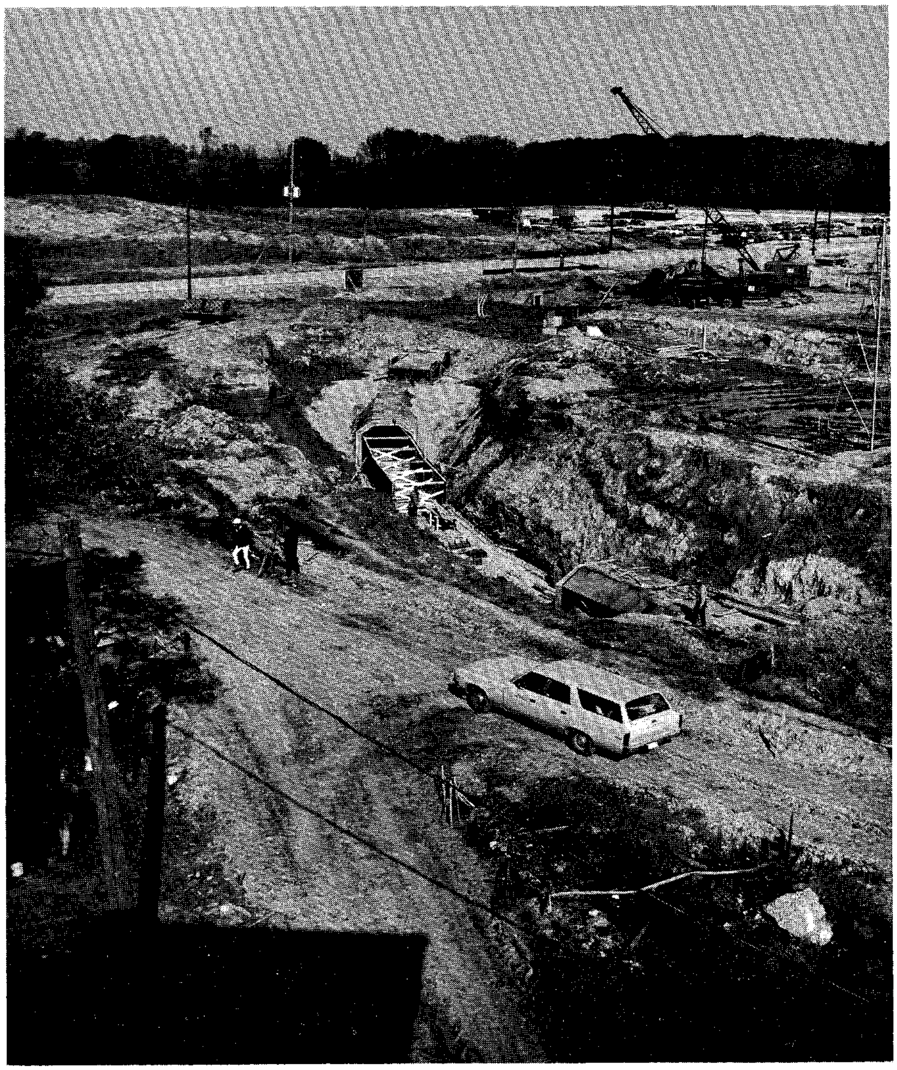

Fig. 1. Work on the last part of the Booster tunnel.

c. Cross Gallery. Figure 2 shows the cross-gallery work. The lower level of the structure, which will provide access to the booster, is now being constructed. The contract is 29% complete.

d. Main Accelerator (Phase I). The excavation for the Transfer Hall is shown on the cover. In addition, precast tunnel sections are being fabricated at a farm on Eola Road east of the ring, as shown in Fig. 3. The contract is 7% complete.

Fig. 2. The Cross Gallery, looking from the Linac toward the Main Ring.

Fig. 3. Precast Main-Ring tunnel sections. Vernon Kenney of AEC is to the left.

e. Ring Road. It is now possible to drive (at some cost to the vehicle) about halfway around the ring on this road, which can be seen on the cover. The contract is 38% complete.

f. Industrial-Area Buildings. The site of these two buildings is in the distance in the cover picture. Form work for the foundation is almost finished and the contract is 7% complete.

5. Experimental Facilities Workshop. The workshop held October 27 attracted a large number of participants from all over the United States. It

is discussed further under "Experimental Facilities" below. The next Workshop will be held at the Laboratory on December 12, starting at 10 a.m. The topic will be spectrometer systems. Interested physicists are invited to participate, as at the first Workshop.

6. Equal Opportunity. K. R. Williams, head of the Equal Opportunity Office of the Laboratory, and his staff have been active in a number of different projects. Close liaison is maintained with prospective and present subcontractors and vendors to help them in their Affirmative Action Programs. The Office also works to encourage the employment of minority contractors. Thirteen minority contractors have held or are holding contracts with the Laboratory and several minority firms are working as subcontractors in the construction of permanent Laboratory buildings, including one subcontract for $340,000. The Laboratory is also buying supplies and equipment from an additional six firms owned and operated by minority entrepreneurs. One of these purchases is for approximately half the main-accelerator bending-magnet laminations.

The Equal Opportunity Office has managed the technical training program whose graduates are now working in our laboratories and design sections. A second apprentice training program for operating engineers is being planned, to be held this time on our site. This program will be sponsored by the Operating Engineers Union.

Linac

1. 10-MeV Prototype. The buncher ahead of the linac tank has been installed and is operating. It has, as predicted, improved the efficiency of capture of protons into stable orbits in the linac. Currents well over 100 milliamperes

are now being accelerated, considerably more than the nominal design intensity.

2. <u>200-MeV Fabrication.</u> The high-voltage set arrived from Switzerland on schedule. Its installation will begin as soon as the electrostatic shielding in the "head house," the preaccelerator pit of the Linac Building, is finished.

Other components of the 200-MeV linac are generally on schedule. Some quality control problems are being encountered with some of the copper-clad steel for the linac tanks, but the procurement is being rearranged so that these problems will not delay final delivery of the tanks.

Booster

1. <u>Booster Prototype.</u> A prototype module (1F-and 1D-magnet on a girder) was evacuated and excited to full power on October 15 (at approximately 4 a.m.). Even at peak-field levels corresponding to 10 GeV, well above the 8-GeV design energy, there was no significant vibration. By the end of October, the Booster Section was operating two complete modules (4 magnets) at the 10-GeV level. Figure 4 shows the booster prototype in its present configuration. The magnets, two built at the Laboratory and two built by private industry, are true production prototypes; they include the curved stacking of the final design. The chokes and capacitors are also production prototypes built by private industry.

The success of these tests is important, because it allows the booster section to proceed at full speed with procurement of all components. We are very grateful for the loan of power supplies by Brookhaven National Laboratory, which made these tests possible.

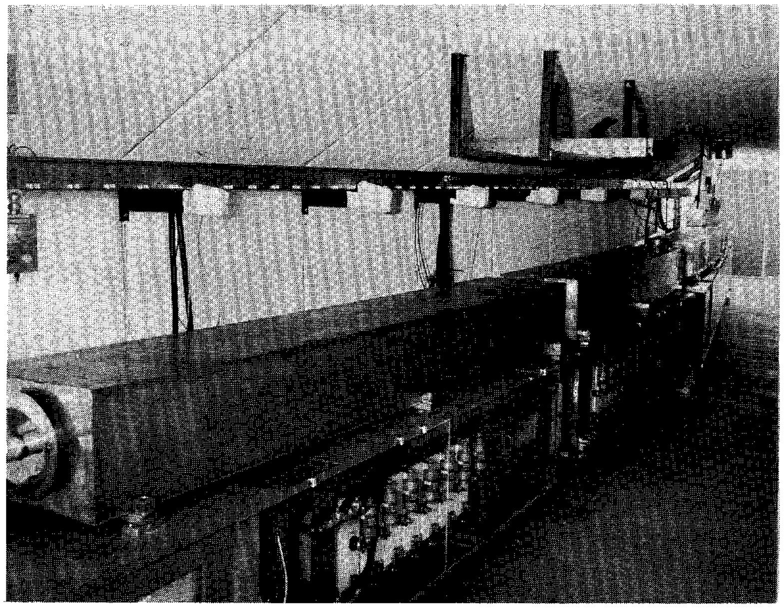

Fig. 4. The Booster prototype. Chokes and capacitors are mounted on the girder under the magnets.

2. Magnet System. The stamping of D laminations is proceeding apace, with no measurable deviation from the pole profile and burr well within acceptable limits. There have been instances of chipping of an outer corner of the F-lamination die and the Booster Section is working to keep the stamping on schedule.

Orders have been placed for the full production quantities of the chokes and capacitors of the energy-storage system of the magnet power supply.

Main Accelerator

1. Groundbreaking. An informal ceremony was held October 3 to break ground for the main-ring enclosure. Members of the Main-Ring Section and many others from DUSAF, AEC, and the Laboratory participated. Figure 5 shows the ceremony at the height of the activity.

2. Main-Accelerator Prototype. We have set ourselves the goal of having a complete cell (8 bending magnets and 2 quadrupoles) installed and operating in the prototype tunnel in the Village by March 20, 1970. The magnets for

this goal will be assembled in the magnet factory discussed below. The operation of this cell will teach us many things about the final accelerator and will, in addition, help in getting the factory into operation.

Fig. 5. Groundbreaking for the Main-Ring Enclosure. The bareheaded gentleman is saying, "Let's finish the ring, then have lunch!"

3. Plans for Magnet Production. The rented factory building in West Chicago mentioned in last month's report will be developed into a magnet-production facility. All the inner coils of the bending magnets will be fabricated and approximately 10% of the bending-magnet cores stacked and assembled here. Most of the bending-magnet cores, all of the bending-magnet outer coils and all of the quadrupole cores and coils will be fabricated by private industry. All assembly of cores, coils, and vacuum chambers into complete bending magnets and quadrupoles will be done on production lines we are now setting up at the West Chicago facility. Mechanical, electrical, and magnetic testing

of the completed magnets will also be done at this facility, which is being equipped to produce magnets at a rate to meet the goal of completing installation of main-ring components by July 1, 1971.

Figure 6 shows the almost-empty factory with a partially completed inner coil. Since this picture was taken, considerably more equipment has been moved over from the Village.

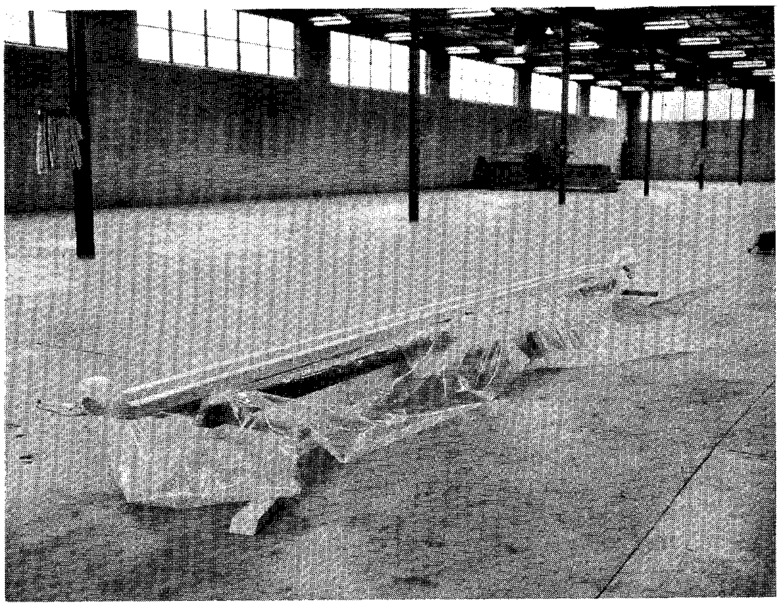

Fig. 6. The West Chicago magnet factory. A wrapped inner coil awaiting potting is on the floor.

Radio Frequency

1. Ferrite Tests. High-power tests have been completed on four possible ferrites for the booster cavities. An interesting time-dependent effect has been observed in this work. When the rf magnetic field reaches a threshold value, power is rapidly absorbed from the fundamental to other modes, reducing the rf amplitude. An example is shown in Fig. 7. The other power-absorbing modes are interpreted as electron-spin modes.

It is essential that the ferrite not be driven into this high-loss region during the acceleration cycle. Two of the four ferrites have been shown to be most advantageous for both booster and main accelerator cavities and are therefore being ordered.

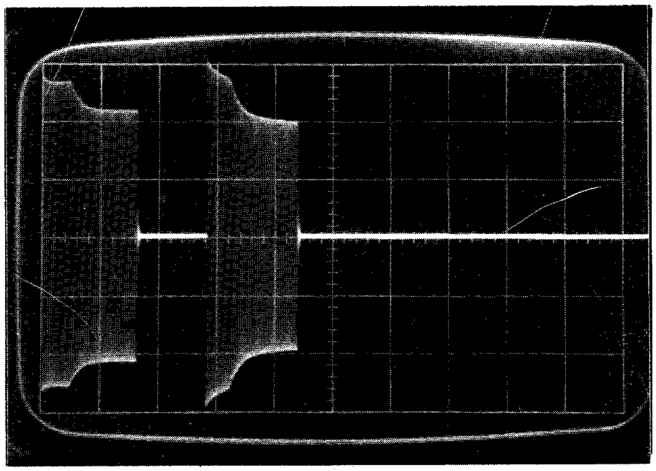

Fig. 7. Power absorption in ferrite sample. The ordinate is magnetic field (20 G/division) and the abscissa is time (2 milliseconds/division).

2. Multipactor Cavity. A test cavity, shown in Fig. 8, has been built duplicating the accelerating gap and insulator geometry of one end of a booster cavity. It has been used to test multipactoring effects.

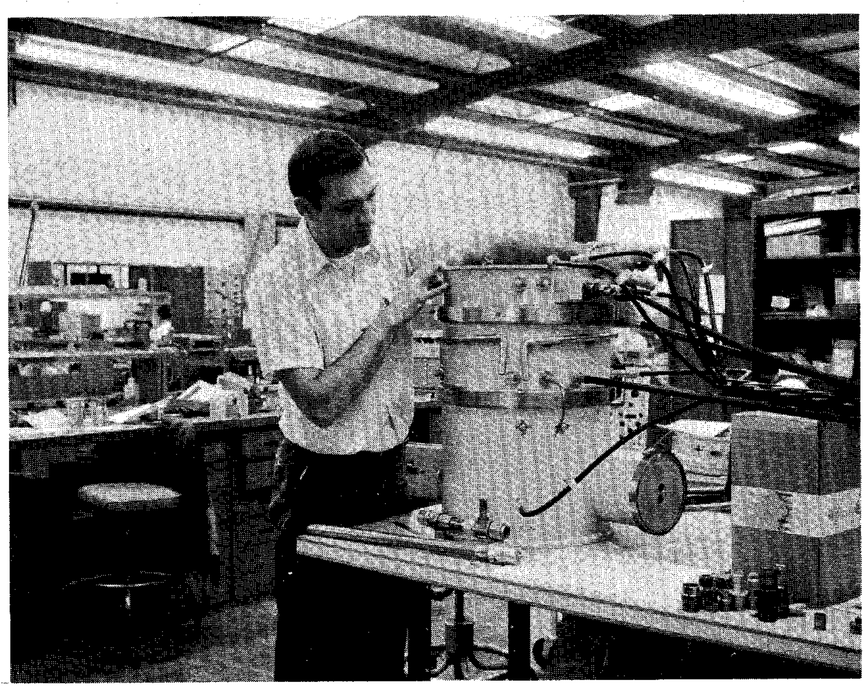

Fig. 8. The multipactor test cavity, with John Zuk.

At certain field levels, an electron will be accelerated across the gap in just one-half of an rf cycle. The secondary electrons created when this electron strikes the electrode will then be accelerated back across the gap in the other half of the rf cycle, when the field is in the opposite direction. They in turn will create more secondary electrons, starting an avalanche that will absorb power from the rf field and stop the buildup of rf amplitude. This multipactoring phenomenon can be overcome by jamming through the dangerous field level quickly by applying high rf power.

The tests on the multipactor cavity show that the phenomenon occurs, as predicted, between 300 and 1500 volts. This would interfere with the slow rise of voltage used at injection into the booster to capture protons into stable orbits. It is planned to avoid this problem by starting adjacent cavities 180° out of phase (so that the energy gains they impart to protons cancel out), jumping quickly across the multipactor region, and changing the relative phase of two cavities to give the right buildup of energy gain.

Experimental Facilities

Workshop on Experimental-Area 2. Concepts of Area 2, the first area to be built, were presented by Laboratory staff members at the first Workshop on October 27, which was attended by 60 physicists from many institutions.

It is planned that Area 2 will contain approximately 6 particle beams, providing a wide range of experimental opportunities. This set of beams is expected to be semi-permanent. That is, the front ends (targets and close-in magnets) and beam transport are expected to be used without substantial change for several series of experiments, as opposed to Area 3, in which flexibility will be emphasized.